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DTU Environment
Department of Environmental Engineering

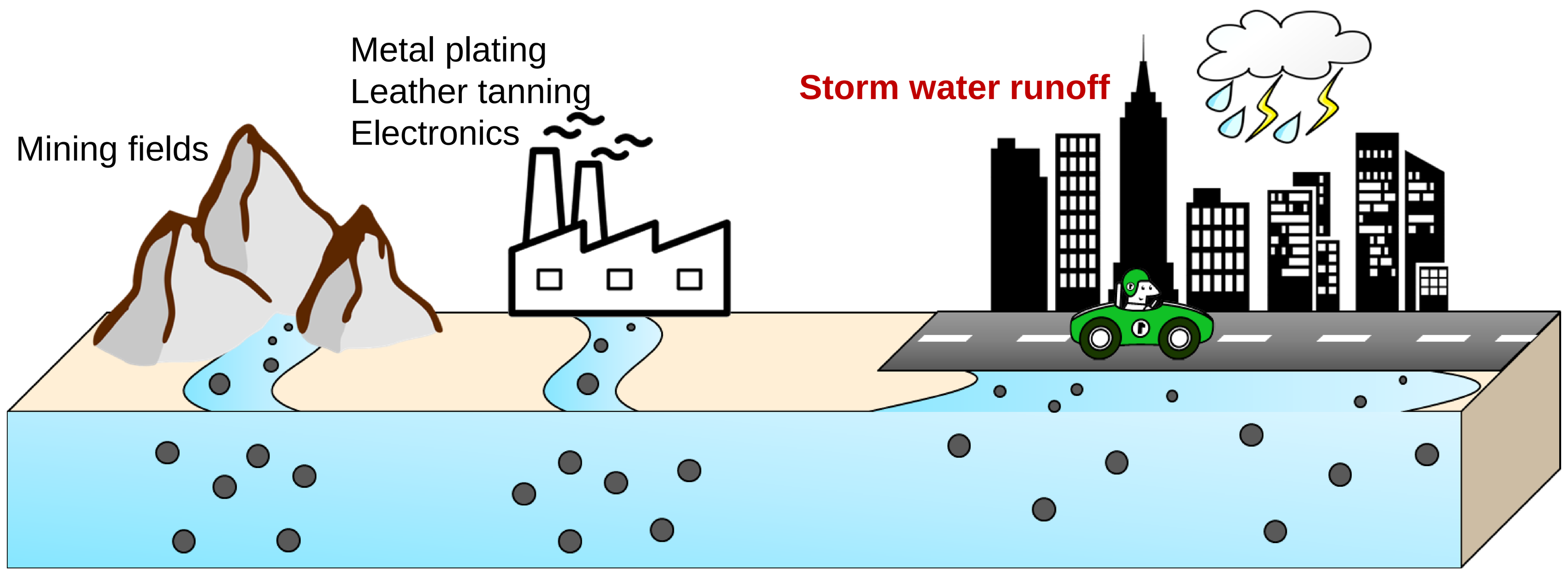
Selective heavy metal capture from contaminated water with covalent organic polymer

Dongah Ko[1], Joosung Lee[2], Mogens H. Jakobsen[3], Yuhoon Hwang[4], Cafer T. Yavuz[2], Henrik R. Andersen[1]

doko@env.dtu.dk

1. Heavy metal contamination

Among various pollutants, **heavy metal ions** have been extensively generated for many years even though their toxicity toward human beings and the environment in general are well known.



2. Limitations & Aims of this study

Limitations of current treatment systems

Lack of adequate space for infrastructure in urban areas

Cost inefficiency

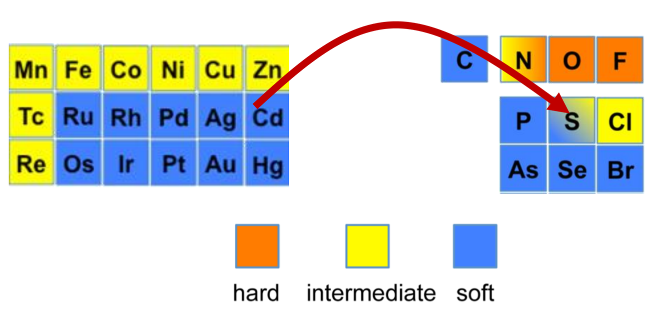
Suggesting new sorbent

- ✓ High capacity → Facilitate compact treatment system in a city
- ✓ High selectivity → Specifically capture heavy metal in a presence of other cations
- ✓ Fast kinetics → Storm water has short retention time
- ✓ Robust structure from covalent bonding → Avoid to be swept away

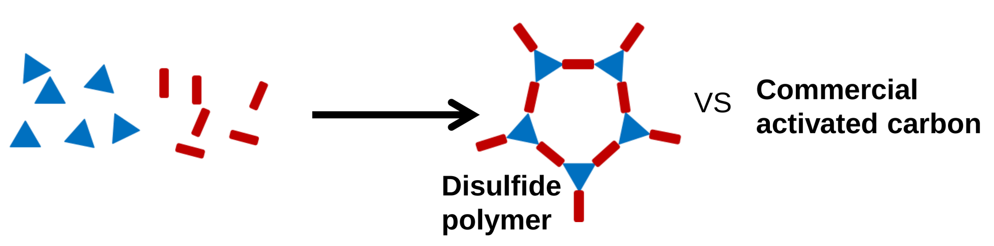
3. Experimental methods

Principle: Hard Soft Acid Base theory

$Cd^{2+} + S^{2-} \rightarrow CdS$



Phase 1: Design and synthesize stable polymer with sulfur functionality

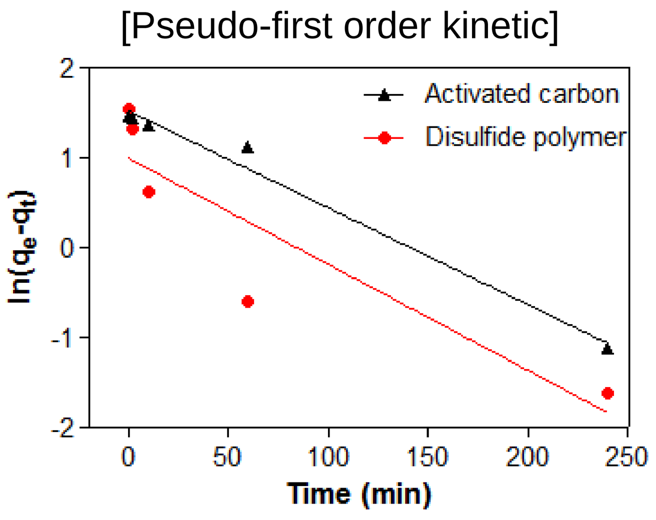


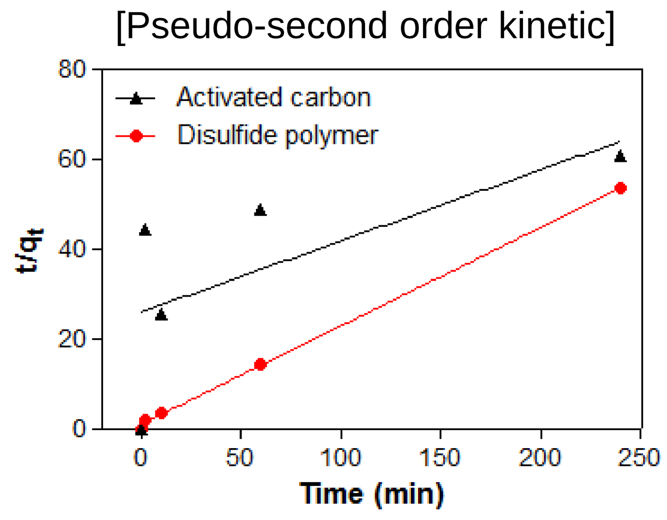
Phase 2: Heavy metal sorption test

1. Pure metal ion test
2. Adding Ca^{2+} or Mg^{2+} in metal solution
3. Sorption tests in different pH conditions

4. Result and Discussion

Sorption kinetics

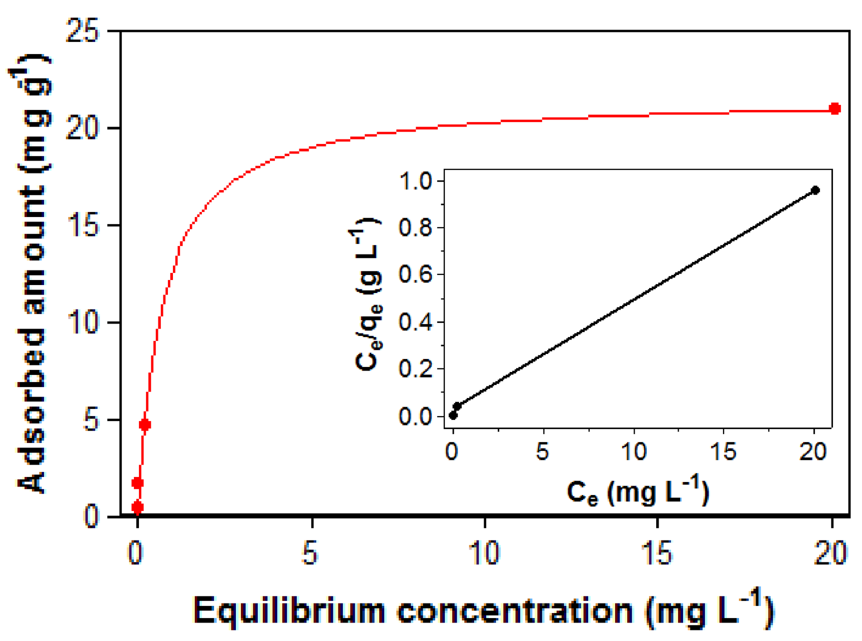




- ✓ Activated carbon sorption kinetic is suitable with pseudo-first order kinetic model (physisorption) and k_1 is 0.01 min^{-1}.
- ✓ Whereas, disulfide polymer correlates to pseudo-second order kinetic model (Chemisorption) and has k_2 of 13.5 g mg^{-1} min^{-1}.

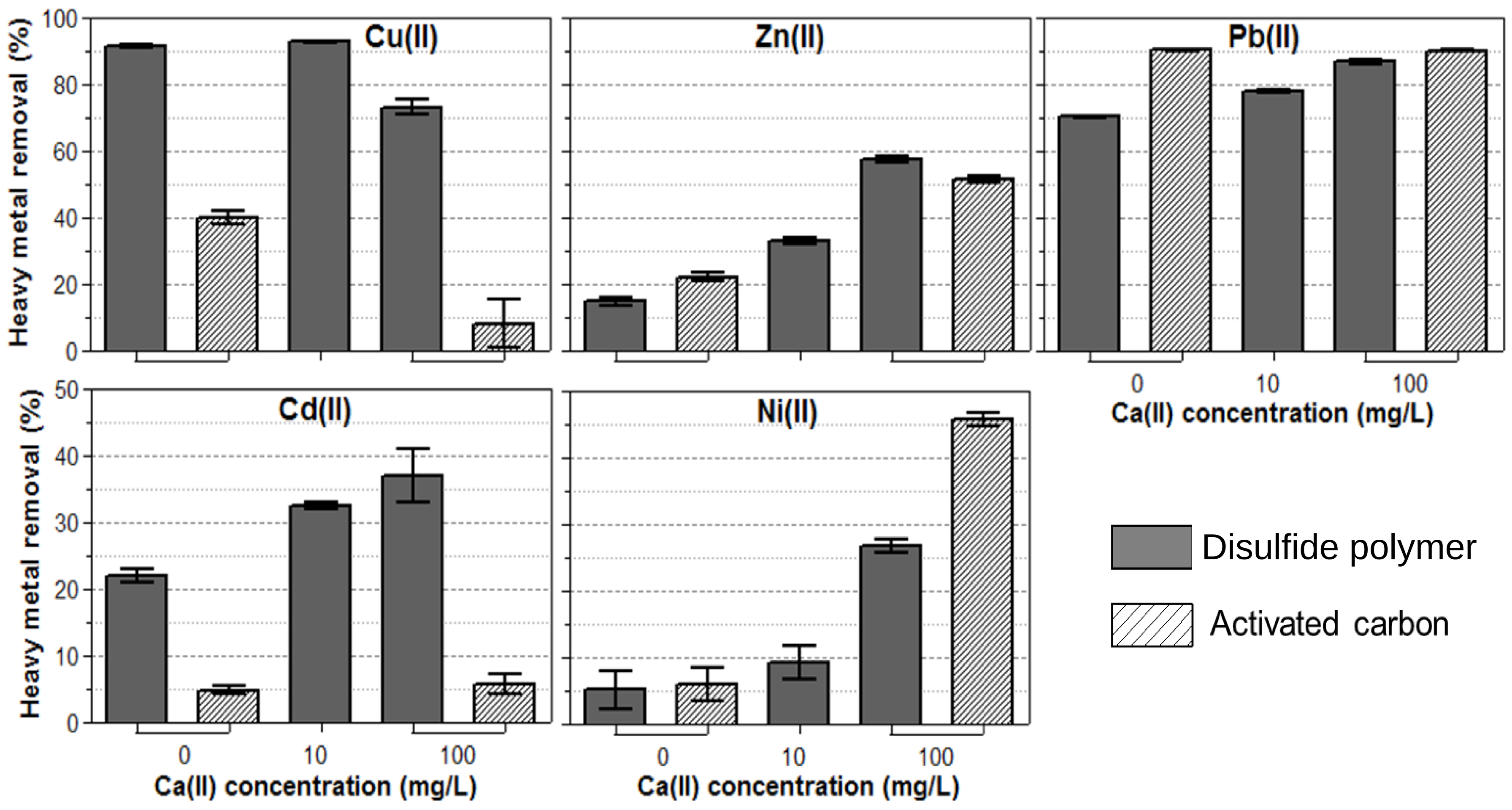
Sorption capacity

	Disulfide polymer	Activated carbon
Maximum capacity (mg/g)	21.1	11.9
K_d (ml/g)	9.49 x 10^5	4.28 x 10^4
Capacity per area (mg/m^2)	0.14	0.01



Selectivity

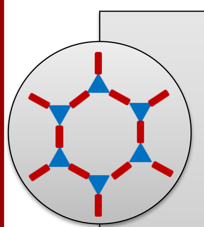
- ✓ Real wastewater also contains other cations such as Ca(II) and this ions compete with heavy metal ions towards sorption sites of sorbent.
- ✓ Cu(II), Zn(II), Pb(II), Cd(II) sorption test showed that in the presence of Ca(II), disulfide polymer shows higher selective capture ability than activated carbon. Ni(II) exhibited opposite result, compared to other metals.



- ✓ Disulfide polymer has 2 times higher sorption capacity and 10 times higher surface area capacity compare to commercial activated carbon.
- ✓ Water-solid partition coefficient shows higher than 10^5, which indicates polymer is an excellent sorbent.

4. Conclusion

Designed porous polymer

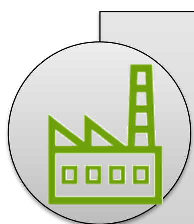


- ✓ Facilitate disulfide functionalized polymers by simple reaction & mild condition.
- ✓ Sulfide group gives strong affinity towards heavy metal ions.

Performance

- ✓ Achieved 99.9% removal of Cd ions.
- ✓ Selectively capturing heavy metal ions in the presence of other cations.

Application



- ✓ Storm water runoff treatment in urban area.
- ✓ Less turn over rate of column.

[1] Department of Environmental Engineering, Technical University of Denmark, Miljøevej 113, 2800 Kgs. Lyngby, Denmark (doko@env.dtu.dk)
[2] Graduate School of EEWS, Korea Advanced Institute of Science and Technology (KAIST), Daejeon 305-701, Republic of Korea
[3] Department of Micro- and Nano technology, Technical University of Denmark, Ørsteds Plads, 345B, 2800 Kgs. Lyngby, Denmark
[4] Department of Environmental Engineering, Seoul National University of Science & Technology, 232 Kongnung-ro, Nowon-gu, Seoul 139-743, Republic of Korea